NSS
Neutrosophic Sets and Systems, Vol. 85, 2025
University of New Mexico

HyperSoft Set and MCDM Methodology for Impact of a Volleyball Program on Undergraduate Students' Physical Fitness and Health Elements

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Abstract: Using a multi-criteria decision-making framework, this study assesses how an organized volleyball program affects undergraduate students' physical fitness and health-related factors. The study evaluates 10 alternatives according to their involvement and program development, and it establishes eight important characteristics that represent advances in physical and health. To guarantee thorough assessment, the system combines quantitative performance measurements with qualitative observations. We use eight criteria and ten alternatives. We use the REGIME method to rank the alternatives. We use the HyperSoft set to deal with different criteria values. The findings show that participants' levels of improvement varied, underscoring the volleyball program's potential as a useful, entertaining tool for improving student health. Results back up the use of team sports in higher education institutions' health promotion initiatives.

Keywords: HyperSoft Set; MCDM Methodology; Volleyball Program; Physical Fitness and Health Elements; Students

1. Introduction

Major institutions have greatly increased volleyball's popularity, and college students are particularly interested in playing the sport. As a result, volleyball's growth in colleges and universities follows a specific scale. Furthermore, pertinent courses are always getting better. In

contrast to other sports, volleyball has specific demands on college students' athletic prowess as well as skill level needs[1], [2].

Consequently, playing volleyball greatly contributes to raising college students' general caliber. Additionally, playing volleyball mostly involves aerobic exercise, and this activity clearly improves college students' cardiopulmonary endurance. The goals of volleyball programs at professional sports colleges and colleges and universities varies significantly. However, they all serve to enhance college students' general physical well-being. Daily volleyball practice can significantly enhance college students' mental health, social skills, and quality of life while also reducing their negative emotions[3], [4].

We can assist in improving the college volleyball course by researching how the course affects the physical attributes of college students. It can serve as an adequate reference for college students' training and is essential to the growth of collegiate athletics[5], [6].

The physical education (PE) program that they offer their students must be assessed by physical educators. This is significant because physical education can help pupils get the recommended quantity of physical activity. This can then help to counteract the rise in obesity by lowering the prevalence of physical inactivity among students. Health-related fitness evaluations are one method of assessing a physical education curriculum[7], [8].

Schoolchildren's fitness levels have increased because of PE activities. However, university students rarely do such studies. Furthermore, no research has been done to ascertain how volleyball training affects university students who are not athletes. This is noteworthy because volleyball is a competitive sport that primarily uses explosive strength and stamina to execute skills like smashing and blocking. The purpose of this study was to ascertain how a volleyball course affected the male university students' health-related fitness[9], [10].

A basic human activity, decision-making takes place in many facets of daily life. It is a mental process that entails weighing several possibilities and choosing the one that best suits the decision-makers' objectives or requirements[11], [12]. Deterministic approaches, which assumed certainty in the process, were the focus of early decision-making research. However, ambiguity frequently occurs in decision-making because of our limitations in fully comprehending the objective reality. Accurately comprehending and characterizing this uncertainty has proven to be difficult for scholars[13], [14].

Making decisions frequently entails weighing several options according to several criteria, which can have a big impact on results in different situations. A methodical technique for assessing and choosing options based on several criteria is called multi-criteria decision-making, or MCDM. By carefully examining trade-offs between factors like cost, quality, performance, and risk, it helps decision-makers evaluate a variety of possibilities. MCDM is frequently used to assist with complicated decision-making issues in domains such as business, engineering, medicine, and disaster management[15], [16].

Instead, then choosing the best option, most of these decision-making situations require ranking all the available options. One of the significant MCDM difficulties, for example, is the assessment of the Impact of a Volleyball Program on Undergraduate Students' Physical Fitness and Health Elements, which ranks the alternatives based on their criteria by considering various characteristics[17], [18].

The aim of this study is organized as follows:

HyperSoft Set is used in this study to deal with different criteria values in the decision-making process.

Eight criteria and ten alternatives are used to evaluate the Impact of a Volleyball Program on Undergraduate Students' Physical Fitness and Health Elements.

The average method is used to compute the criteria weights in the decision matrix between the criteria and alternatives.

The REGIME method is a MCDM is used to rank the alternatives based on a set of criteria.

2. HyperSoft Set with Decision Making Method

This section shows the definitions of HyperSoft set and the steps of the MCDM approach to rank the alternatives.

By linking qualities (or parameters) to subsets of a universal set, a Soft Set provides a simple method for parameterized decision modeling that successfully addresses uncertainty in a structured way. To address various facets of uncertainty, several related mathematical frameworks have been created, including fuzzy sets, neutrosophic sets, and rough sets. The HyperSoft Set expands on this framework by adding multi-attribute decision modeling to Soft Sets. A HyperSoft Set enhances its ability to handle complicated decision-making scenarios by mapping combinations of numerous qualities to subsets of the universal set rather than assigning a single parameter to a subset[19], [20].

Let U be a universal set and set of criteria such as $C_1, C_2, \dots, C_m$. The cartesian product of these criteria can be obtained as: $C = C_1 \times C_2 \times \dots \times C_m$. The HyperSoft set over U is a pair (A, C) and $A: C \to P(U)$. We can define the HyperSoft Set as:

$$(A, C) = \{(y, A(y)) | y \in C, A(y) \in P(U)\} \quad (1)$$

$y = (y_1, y_2, \dots y_m) \in C; y_i \in C_i; i = 1,2, \dots, m, A(y)$ shows the subset of U of criteria values $y_1, y_2, \dots y_m$ (2)

We show the steps of the REGIME with the HyperSoft Set to rank the alternatives.

Create the decision matrix using the scale between 0 and 1. We combine these numbers into a single matrix. Create the weights of criteria by the average method.

Calculate the superiority index A_{fl}.

Calculate the superiority identifier.

$$A_{fl} = \sum_{j \in E_{fl}} w_j \tag{3}$$

Create the impact matrix.

Create the REGIME matrix among the options.

$$A_{fl,j} = \begin{cases} -1 & if\ u_{fj} < u_{lj} \\ 0 & if\ u_{fj} = u_{lj} \\ +1 & if\ u_{fj} > u_{lj} \end{cases} \tag{4}$$

Calafate the guide index.

$$B_{fl} = \sum_{j=1}^{n} A_{fl}\, w_j \tag{5}$$

3. Results

This section shows the results of the proposed approach. We use eight criteria with values for HyperSoft Set and ten alternatives such as:

- C1. Cardiovascular Endurance Low, Moderate, High
- C2. Muscular Strength Weak, Average, Strong
- C3. Flexibility Poor, Fair, Good
- C4. Body Composition Overweight, Normal, Lean
- C5. Agility Slow, Moderate, Fast
- C6. Coordination Below Average, Average, Excellent
- C7. Mental Wellbeing Low Motivation, Stable Mood, Highly Engaged
- C8. Participation Consistency Irregular, Regular, Highly Consistent

- Cardiovascular Endurance (C1): Measures improvements in stamina and aerobic capacity through timed running and heart rate recovery tests.
- Muscular Strength (C2): Assesses upper and lower body strength using metrics such as bench press and squat repetitions.
- Flexibility (C3): Evaluated through sit-and-reach tests to determine the extent of flexibility gains, especially in the lower back and hamstrings.
- Body Composition (C4): Tracks changes in fat mass and lean muscle ratio, based on BMI and body fat percentage analysis.
- Agility (C5): Measures quick directional changes and reaction time using shuttle run and cone drills.
- Coordination (C6): Observed through volleyball-specific drills like passing accuracy and ball control tasks.
- Mental Wellbeing (C7): Surveys and interviews used to evaluate reductions in stress and improvements in mood due to regular participation.

- Attendance and Participation Consistency (C8): Quantifies commitment and motivation through attendance records and active engagement levels.

Three experts created the decision matrix between the criteria and alternatives. We combined the decision matrix and computed the criteria weights using the average method.

C1 – (0.1221) This criterion assesses how effectively the volleyball program improves the ability of the heart and lungs to supply oxygen during sustained physical activity. With a moderate weight, it reflects a vital but balanced component of overall health.

C2 – (0.1247) This measures the increase in the students' ability to exert force. The volleyball program contributes to developing upper and lower body strength through repeated jumping, hitting, and blocking.

C3 – (0.1320) This criterion evaluates how long students can perform physical activity without fatigue. With a relatively higher weight, it shows the volleyball program's strong influence on building sustained physical performance.

C4 – (0.1284) Flexibility considers the range of motion in joints and muscles, often improved through volleyball's dynamic movements. This criterion has notable importance due to its role in injury prevention and functional movement.

C5 – (0.1209) This relates to the balance of fat and lean mass in the body. The volleyball program helps in managing weight and improving body composition through aerobic and anaerobic exertion.

C6 – (0.1261) This assesses how well participants control body movement during complex actions. Volleyball's rapid shifts and multidirectional play help improve these motor skills, making it a significant aspect of the evaluation.

C7 – (0.1103) This criterion captures the psychological and emotional benefits of participation, such as reduced stress and improved mood. Though slightly lower in weight, it remains a key holistic health component.

C8 – (0.1356) The highest-weighted criterion, emphasizing the volleyball program's role in fostering social bonds, communication, and collaboration among students. This aligns with educational goals promoting interpersonal development alongside physical fitness.

We select the best values such as:

- C1. High
- C2. Strong
- C3. Good
- C4. Normal
- C5. Fast
- C6. Excellent

- C7. Highly Engaged
- C8. Highly Consistent

We calculate the superiority index A_{fl} and calculate the superiority identifier using eq. (3). We create the impact matrix.

We create the REGIME matrix among the options using eq. (4) as shown in Fig 1.

We compute the guide index using eq. (5) as shown in Fig 2. Fig 3 shows the values of guide index. We rank the alternatives as shown in Fig 4.

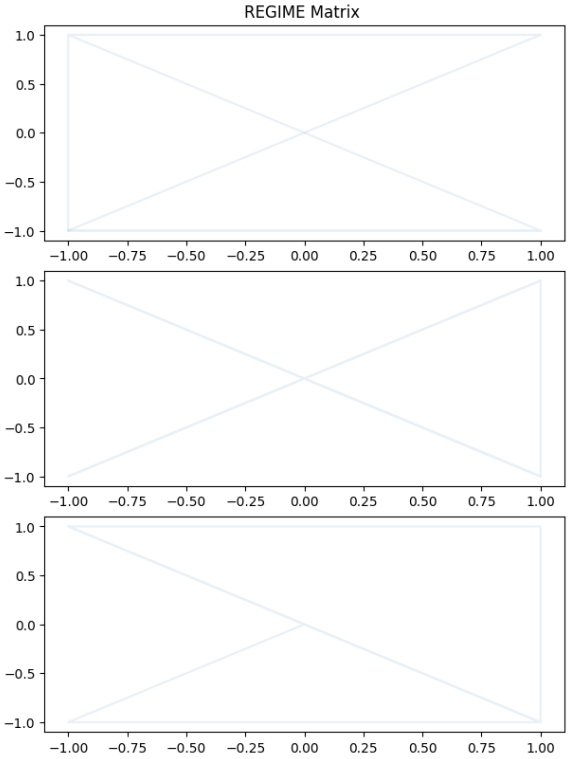

Fig 1-a. The REGIME matrix for A_1.

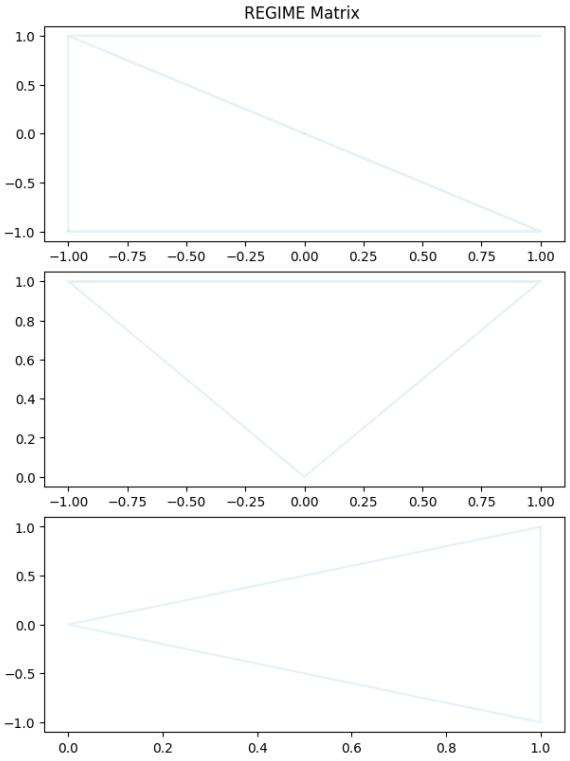

Fig 1-b. The REGIME matrix for A_2.

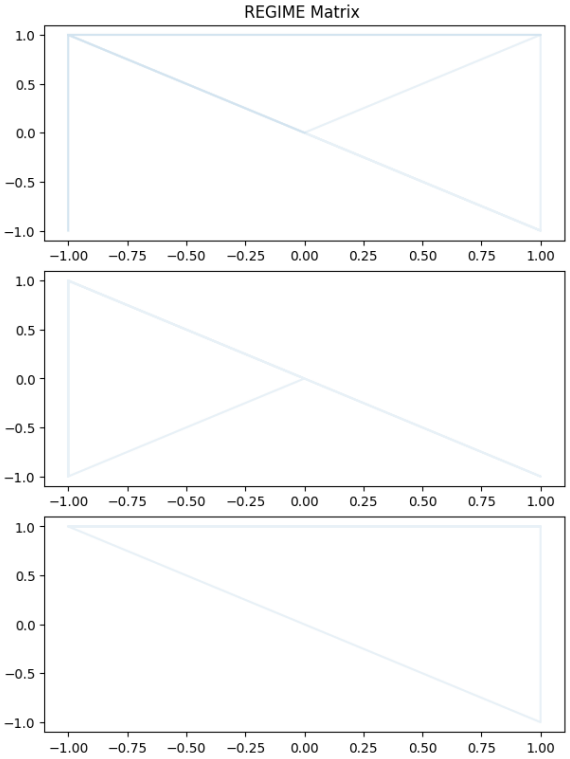

Fig 1-c. The REGIME matrix for A_3.

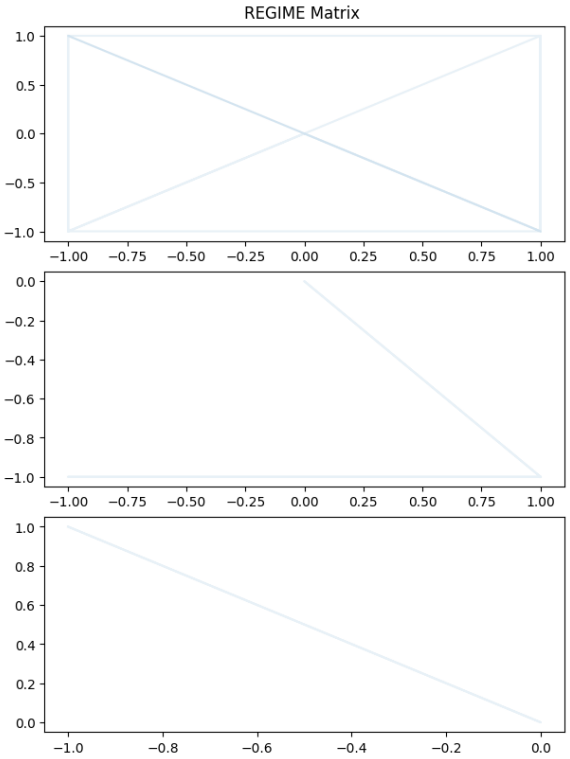

Fig 1-d. The REGIME matrix for A_4.

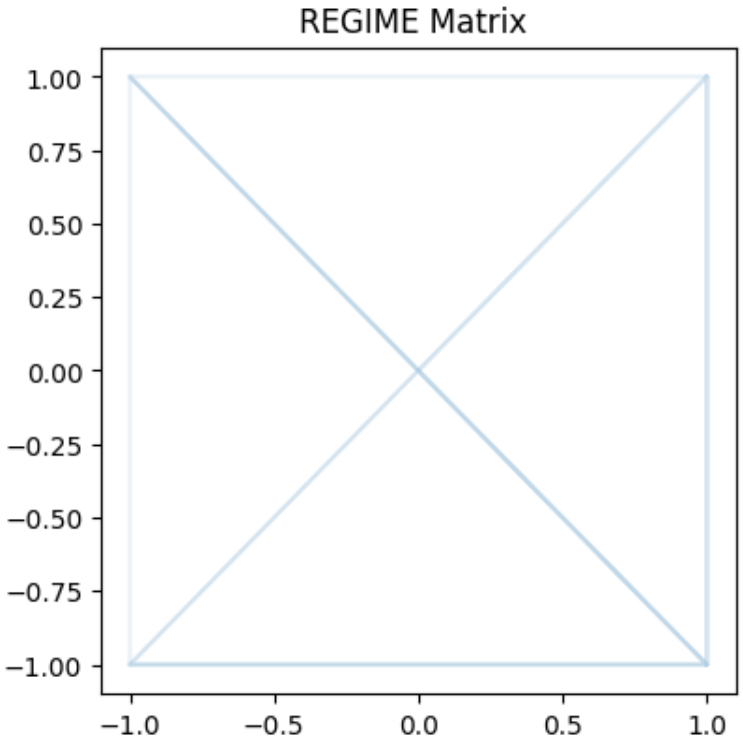

Fig 1-e. The REGIME matrix for A_5.

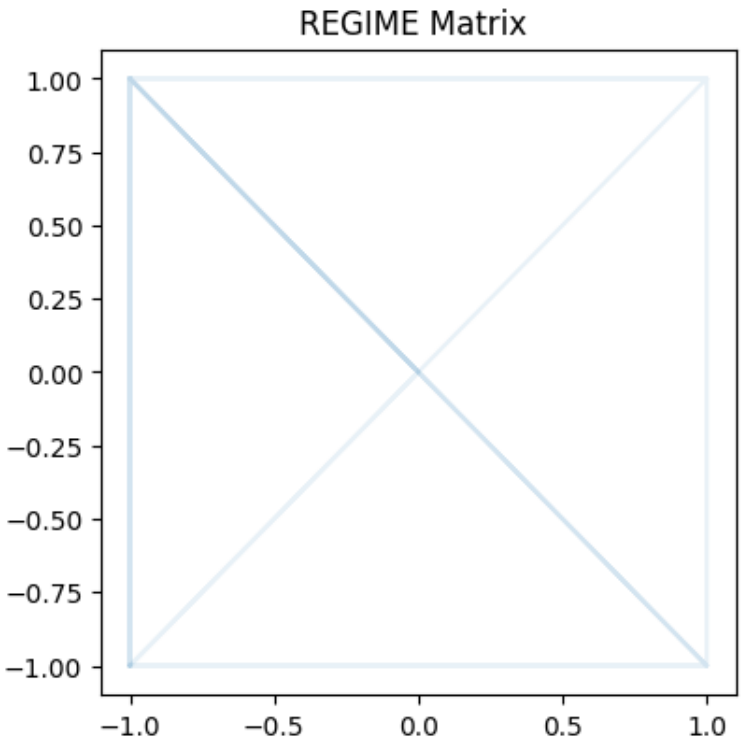

Fig 1-f. The REGIME matrix for A_6.

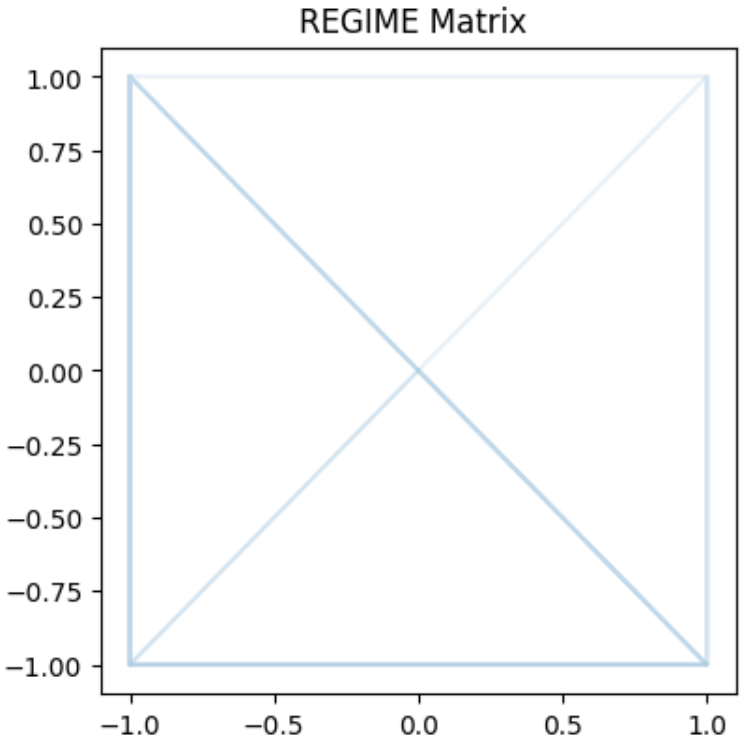

Fig 1-g. The REGIME matrix for A_7.

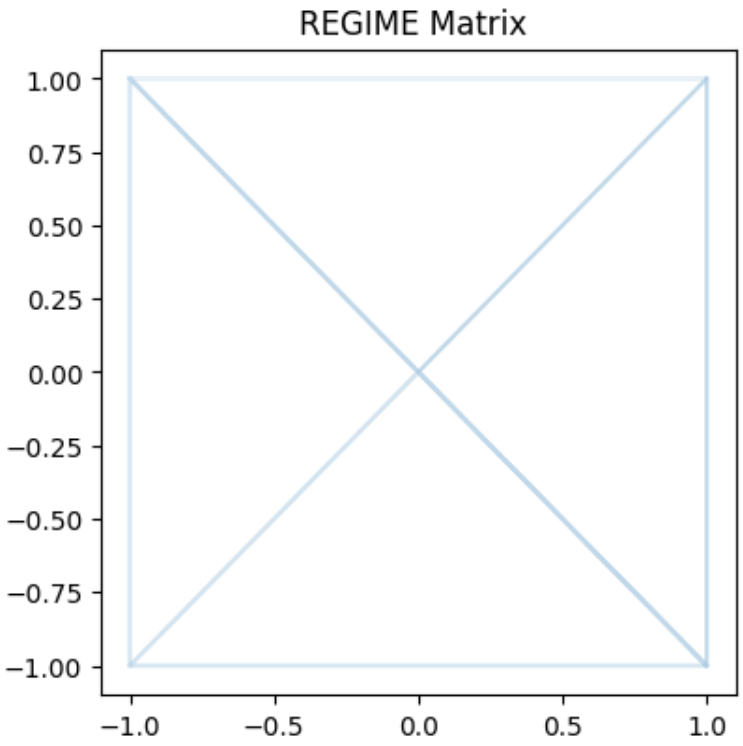

Fig 1-h. The REGIME matrix for A_8.

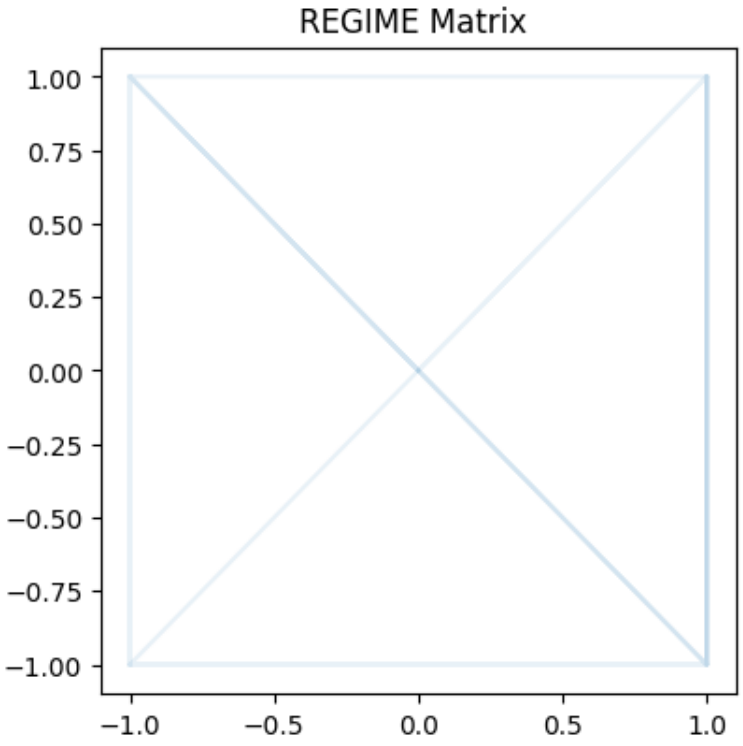

Fig 1-i. The REGIME matrix for A_9.

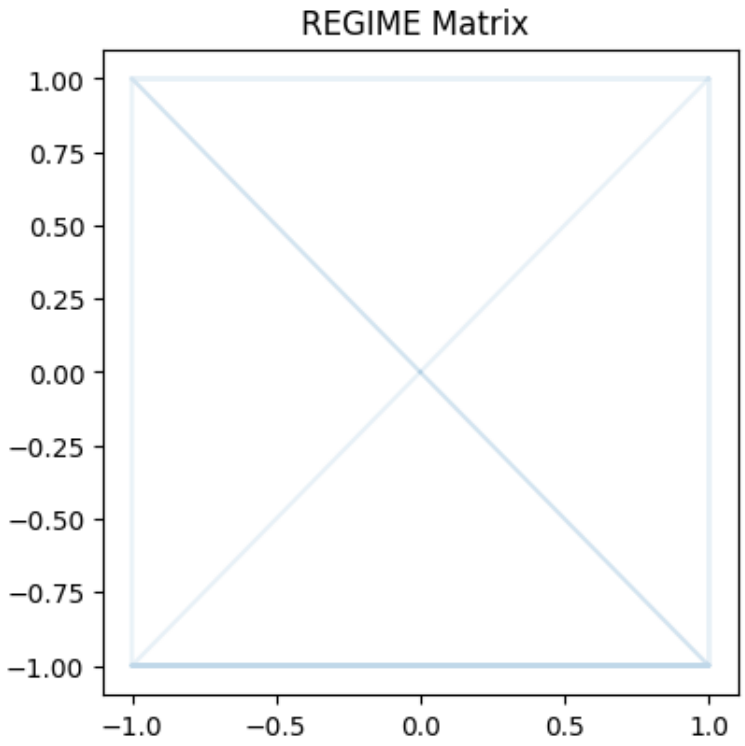

Fig 1-j. The REGIME matrix for A_{10}.

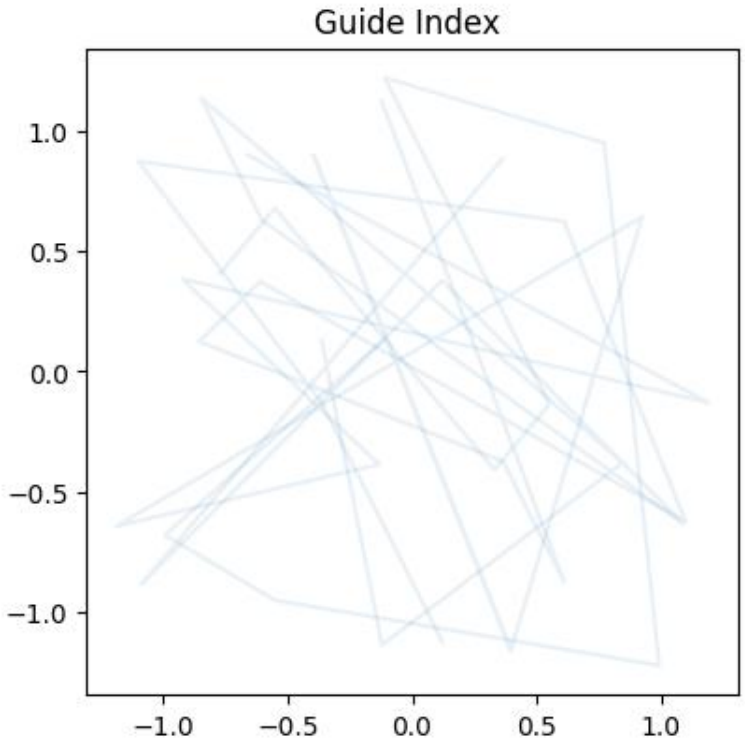

Fig 2. The weighted guide index.

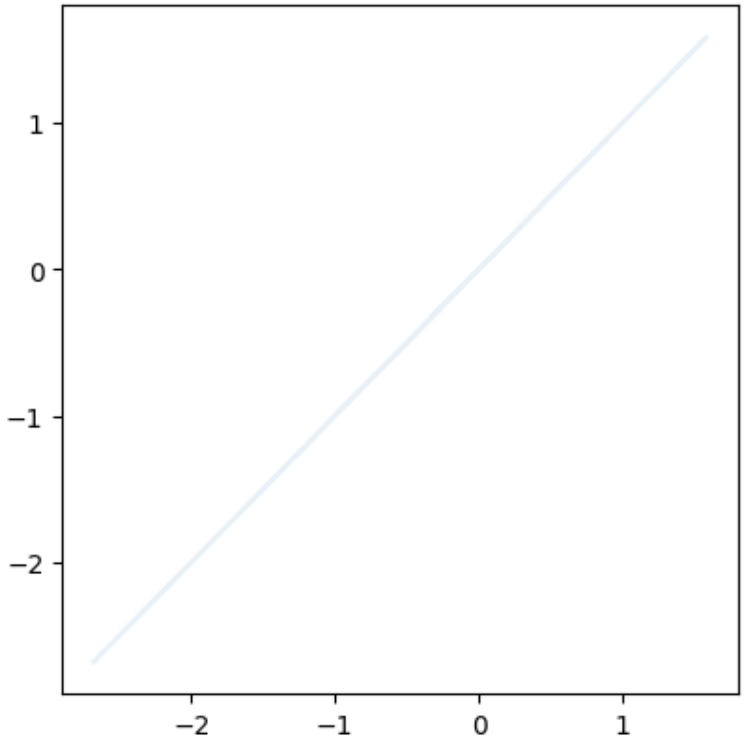

Fig 3. Values of guide index.

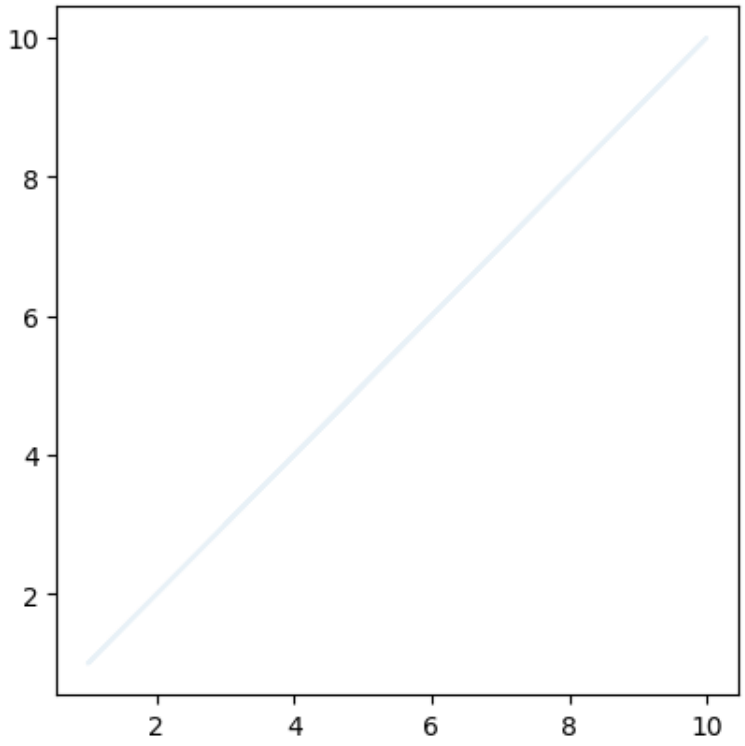

Fig 4. The ranks of alternatives.

A1 – Rank 5

This alternative performed moderately well across the criteria. It shows a balanced improvement in fitness and health elements, placing it in the upper mid-tier among all options.

A2 – Rank 1 (Lowest)

This alternative had the least impact across the evaluated criteria. It might indicate minimal effectiveness of the volleyball program in improving physical fitness and health for this group.

A3 – Rank 2

Slightly better than A2, this alternative still falls in the lower-performing range. It likely showed modest improvements in some areas but lacked consistency across all criteria.

A4 – Rank 8

This is among the stronger-performing alternatives. It demonstrated significant benefits, especially in areas like cardiovascular endurance or social interaction, though not at the very top.

A5 – Rank 4

This alternative showed fairly strong outcomes. It might reflect effective implementation of the volleyball program with notable gains in several key health and fitness criteria.

A6 – Rank 9

A high-performing alternative, indicating substantial benefits from the volleyball program. Likely to have excelled in a combination of physical and psychosocial elements.

A7 – Rank 10 (Highest)

This is the top-performing alternative, showing outstanding results across nearly all criteria. It suggests excellent impact of the volleyball program on students' physical fitness and health.

A8 – Rank 7

On the other hand, this alternative achieved good results, possibly excelling in one or two areas like flexibility or teamwork, but not as comprehensively as A7 or A6.

A9 – Rank 3

A solid alternative that outperformed most others except the top two. It indicates effective engagement and measurable improvements in health metrics.

A10 – Rank 6

Sitting at the center, this alternative showed consistent but not standout results. A generally effective outcome with room for improvement.

5. Conclusions

The study confirms the positive effects of a volleyball program on various dimensions of students' physical health and mental wellbeing. The eight evaluation criteria provided a well-rounded framework to capture improvements beyond physical fitness, incorporating psychological and behavioral aspects. While some participants showed exceptional physical development, others benefitted more in terms of mental health, highlighting the multifaceted benefits of team sports in educational settings. We use the HyperSoft Set to deal with criteria values. The MCDM method is used to select the best alternative. The REGIME method is used to rank the alternatives. Based on the findings, institutions should consider integrating volleyball and similar programs into the curriculum as part of a comprehensive health promotion strategy.

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Received: Nov. 22, 2024. Accepted: April 22, 2025